Application of Microwave Power Transmission

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In our laboratory, there are three main research topics as follows;

- Research of Space Solar Power Station/Satellite (SPS)
- Research of Microwave Power Transmission (MPT) for Various Applications
- Research of Advanced Microwave Processing for Biomass Refinery and Creation of New Materials

In FY2010, we started inter-university collaborative research with a new anechoic chamber with clean room and high power microwave absorbers and high efficiently new phased array with GaN amplifiers and MMIC phase shifters for the SPS and MPT.

Research Activities for the SPS

Based on the inter-university collaborative research, we developed some new MPT system. For the SPS, it is necessary to properly deal with the heat which is generated from power amplifier. We studied the antenna structure which conducted heat form power amplifier to antenna and radiated heat from the antenna surface with IHI Aerospace co., ltd. Via holes in the antenna can conduct heat from the back surface of antenna to the surface of one. The antenna is a crossed slot antenna, which can radiate heat efficiently because the metal surface is large. The antenna has a wavelength selection sheet on the antenna to cut heat from outside to the antenna and radiate heat efficiently. In this paper, we report the results of the thermal characterization test of the antenna.

Collaborative Researches of the MPT applications

We designed and fabricated the rectennas which use class-F load as an output filter in order to develop highly efficient rectennas at 24GHz and 60GHz with NTT co. We also fabricated conventional rectennas which use a capacitor as an output filter, and compared the efficiency of class-F load rectennas with that of capacitor rectennas. We selected the diode which can produce high efficiency even at high frequency, and we parallelized the diode to improve the efficiency. The experimental result of efficiency of class-F load rectennas was 65.6%, on the other hand, that of capacitor rectennas was 52.1%.

Microwave Pretreatment System for Bioethanol Production from Woody Biomass

Efficient pretreatment prior to enzymatic saccharification process is essential for profitable bioethanol production from woody biomass. Microwave pretreatment is expected as an efficient and energy-cost-saving method to enhance enzymatic susceptibility. The objective of the present study is to develop an efficient, high-volume, and continuous microwave pretreatment system toward commercially-based bioethanol production. As a feasibility study, we developed prototypes of a continuous-flow-type microwave pretreatment system for bioethanol production from woody biomass. A unit of the microwave irradiation sections of a continuous-flow-type microwave pretreatment system was designed with a 3D electromagnetic simulator. Prototype experiments and quantitative estimation of energy balance were also conducted. Microwave pretreatment provided 45.9% of the total saccharide yield woody biomass weight by electric consumption of 552 kJ; whereas conventional heating pretreatment provides 43.6 % of the total saccharide yield by 498 kJ, when the mixture was composed of 70 g of woody biomass (Japanese cedar sapwood chips) and 770 g of solvents (ethylene glycol : phosphoric acid = 95 : 5). We estimated 14.8g of bioethanol and 439 kJ of bioethanol energy could be produced by the prototype microwave pretreatment. Although heat dissipation from the metal pipe to the air and the ratio of solvents to woody biomass are immediate problems, microwave is a future potential energy-saving pretreatment method without loss of the saccharide yield.